

Aaron C. Courville

- Contact information:** Département d'Informatique et de recherche opérationnelle
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website: <http://aaroncourville.wordpress.com>
- Research interests:** Machine learning, deep learning, probabilistic models and inference, neural networks, unsupervised learning, computer vision, artificial intelligence, models of cognition, perception and learning, classical and operant conditioning.
- Education:** Carnegie Mellon University, Pittsburgh, PA USA (1999-2005)
Robotics Institute, School of Computer Science &
Center for the Neural Basis of Cognition
Committee:
David S. Touretzky (Advisor), Peter Dayan (External),
Geoffrey J. Gordon, James L. McClelland
Ph.D., 2005
- University of Toronto, Toronto, ON Canada (1993-1999)
Department of Electrical Engineering, Faculty of Applied Science and Engineering
Advisor: Berj L. Bardakjian
M.A.Sc., 1999 (Institute of Biomaterials and Biomedical Engineering)
B.A.Sc., 1997, *Dean's Honours List* (Division of Engineering Science, option: Biomedical Engineering)
- Experience:** Assistant Professor (2012–present)
Département d'Informatique et de recherche opérationnelle, Université de Montréal,
Montreal, Canada
- Senior Research Scientist (2008–2012)
Yoshua Bengio's group,
Département d'Informatique et de recherche opérationnelle, Université de Montréal,
Montreal, Canada
- Postdoctoral Researcher (2005–2008)
Yoshua Bengio's group,
Département d'Informatique et de recherche opérationnelle, Université de Montréal,
Montreal, Canada
- Visiting Researcher (2004-2005)
School of Computer Science, McGill University, Montreal, Canada
- Research Assistant (1999-2004)
David S. Touretzky's group,
Robotics Institute, School of Computer Science, Carnegie Mellon University, Pittsburgh, USA

Research Assistant (1997-1999)
Berj Barkakjian's group,
Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto,
Canada

Research Assistant (Summer 1996)
Berj Barkakjian's group,
Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto,
Canada

Awards:

Winning Team Member of the Transfer Learning Challenge (2011)
NIPS Workshop: <https://sites.google.com/site/nips2011workshop/transfer-learning-challenge>

Winning Team Member of the Unsupervised and Transfer Learning Challenge Phase II (2011)
ICML Workshop: <http://www.causality.inf.ethz.ch/unsupervised-learning.php#cont>

AISTATS People's Choice Award for Poster Presentation (2011)
Courville, Bergstra & Bengio, "The Spike and Slab Restricted Boltzmann Machine"

NIPS Outstanding Student Paper Award (2004)
Courville, Daw & Touretzky, "Similarity and discrimination in classical conditioning"

Natural Sciences and Engineering Research Council of Canada
NSERC Post Graduate Scholarship B, (2000)
NSERC Post Graduate Scholarship A, (1997)

Division of Engineering Science, University of Toronto
Best Design Project (1995)

Murray Calder Hendry Scholarship (1993)

Kadeb Scholarship (1993)

Governor General Award (1993)

Research projects:

Deep Learning Methods (2006-present)
Exploration and development of algorithms capable of learning abstract features as functions of the input. The goal is to learn features that disentangle the factors of variance present in complex data sources such as natural images, music and video.

Facial Expression and Emotional State Recognition (2010-present)
In partnership with Ubisoft, the goal of this project is the development of deep learning algorithms for automatically recognizing and tracking the facial expressions and emotional states of video game players.

Bayesian Nonparametrics (2008-2010)
Development of Nonparametric methods and models that expand the range of phenomena captured by this modeling framework. The focus is on expanding the inferential power of the Indian Buffet Process.

Normative Models of Learning and Behavior (2000-present)

Development of a theory of classical conditioning based on the perspective that animal behaviour arises as a consequence of normative response to its training experience. In this work, the focus is on developing a coherent causal theory of learning that accounts for a wide array of empirical data.

Simultaneous Terrain Modeling and Obstacle Detection (2005-2006)

Design and development of a method to build a probabilistic generative model of the surrounding terrain and to simultaneously use this model to improve the detection of obstacles. The model was designed for deployment on an autonomous tractor. (patent pending)

Stimulation Strategies for Epilepsy (1997-1999)

Exploration in simulation of a strategy for epileptic seizures control through stimulation. The strategy was based on exploiting the difference between the irregular “chaotic” activity apparent in normal brain function and the more regular activity observed before and during seizures.

Theses:

Courville, A. C. (2006) “A Latent Cause Model of Classical Conditioning.” Ph.D. thesis, Robotics Institute, Carnegie Mellon University, Pittsburgh PA USA.

Courville, A. C. (1999) “Chaosmakers for epilepsy.” M.A.Sc. thesis, Department of Electrical and Computer Engineering, University of Toronto, Toronto ON Canada.

Courville, A. C. (1997) “Memory of Neuronal Networks: The White Noise Approach.” B.A.Sc. thesis, Division of Engineering Science, Faculty of Applied Science and Engineering, University of Toronto, Toronto ON Canada.

Refereed journal articles:

Bengio, Y., Courville, A., Vincent, P. “Unsupervised Feature Learning and Deep Learning: A Review and New Perspectives.” IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), Special Issue. [accepted for publication 2013]

Goodfellow, I.J., Courville, A., Bengio, Y. “Scaling up Spike-and-Slab Models for Unsupervised Feature Learning.” IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), Special Issue. [accepted for publication 2013]

Vincent, R. D., Courville, A., Pineau, J. (2011) “A bistable computational model of recurring epileptiform activity as observed in rodent slice preparations” *Neural Networks*, 24(6): 526-537.

Erhan, D., Bengio, Y., Courville, A., Manzagol, P.-A., Vincent, P., Bengio, S. (2010) “Why Does Unsupervised Pre-training Help Deep Learning?” *Journal of Machine Learning Research*, 11: 625-660.

Courville, A.C., Daw, N.D., Touretzky, D.S. (2006) “Bayesian theories of conditioning in a changing world.” *Trends in Cognitive Sciences*, 10: 294-300. (the first two authors contributed equally to these articles, ordering was determined alphabetically)

Wellington, C., Courville, A., Stentz, A. (2006) “A Generative Model of Terrain for Autonomous Navigation in Vegetation.” *The International Journal of Robotics Research*, 25: 1287-1304.

Daw, N.D., Courville, A.C., Touretzky, D. (2006) “Representation and timing in theories

of the dopamine system.” *Neural Computation*, 18: 1637-1677.

**Articles in
Refereed
Conference
Proceedings:**

Luo, H., Carrier, P.L., Courville, A., Bengio, Y. “Texture Modeling with Convolutional Spike-and-Slab RBMs and Deep Extensions.” *Proceedings of the 16th International Conference on Artificial Intelligence and Statistics (AISTATS)*. [accepted for publication 2013]

Desjardins, G., Pascanu, R., Courville, A., Bengio, Y. (2013) “Metric-Free Natural Gradient for Joint-Training of Boltzmann Machines.” *Proceedings of the 1st International Conference on Learning Representations (ICLR)*.

Rifai, S., Bengio, Y., Courville, A., Vincent, P., Mirza, M. (2012) “Disentangling Factors of Variation for Facial Expression Recognition.” *Proceedings of the European Conference on Computer Vision (ECCV)*.

Goodfellow, I., Courville, A., Bengio, Y. (2012) “Large-Scale Feature Learning With Spike-and-Slab Sparse Coding.” *Proceedings of the 29th International Conference on Machine Learning*.

Desjardins, G., Courville, A., Bengio, Y. (2011) “On Tracking The Partition Function.” *Advances in Neural Information Processing Systems 24*.

Mesnil, G., Dauphin, Y., Glorot, X., Rifai, S., Bengio, Y., Goodfellow, I., Lavoie, E., Muller, X., Desjardins, G., Warde-Farley, D., Vincent, P., Courville, A., and Bergstra, J. (2011) “Unsupervised and Transfer Learning Challenge: a Deep Learning approach” *JMLR W&CP: Proc. Unsupervised and Transfer Learning*, 7.

Courville, A., Bergstra, J., Bengio, Y. (2011) “Unsupervised Models of Images by Spike-and-Slab RBMs.” *Proceedings of the 28th International Conference on Machine Learning*: 1145-1152.

Courville, A., Bergstra, J., Bengio, Y. (2011) “The Spike and Slab Restricted Boltzmann Machine.” *Proceedings of the 14th International Conference on Artificial Intelligence and Statistics (AISTATS)*: 233-241.

Erhan, D., Courville, A., Bengio, Y., Vincent, P. (2010) “Why Does Unsupervised Pre-training Help Deep Learning?” *Proceedings of the 9th International Conference on Artificial Intelligence and Statistics (AISTATS)*: 201-208.

Desjardins, G., Courville, A., Bengio, Y., Vincent, P., Delalleau, O. (2010) “Tempered Markov Chain Monte Carlo for training of Restricted Boltzmann Machines.” *Proceedings of the 9th International Conference on Artificial Intelligence and Statistics (AISTATS)*: 145-152.

Courville, A., Eck, D., Bengio, Y. (2010) “An Infinite Factor Model Hierarchy Via a Noisy-Or Mechanism.” *Advances in Neural Information Processing Systems 22*.

Daw, N., Courville, A. (2008) “The Pigeon as Particle Filter” *Advances in Neural Information Processing Systems 20*.

Larochelle, H., Erhan, D., Courville, A., Bergstra, J., Bengio, Y., (2007) “An Empirical Evaluation of Deep Architectures on Problems with Many Factors of Variation.”

Proceedings of the 24th International Conference on Machine Learning: 473-480.

Wellington, C., Courville, A., Stentz A. (2005) “Interacting Markov Random Fields for Simultaneous Terrain Modeling and Obstacle Detection.” Proceedings of Robotics: Science and Systems, I: 1-8.

Courville, A.C., Daw, N.D., and Touretzky, D.S. (2005) “Similarity and discrimination in classical conditioning: A latent variable account.” Advances in Neural Information Processing Systems, 17: 313-320.

Courville, A.C., Daw, N.D., Gordon, G.J., and Touretzky, D.S. (2004) “Model uncertainty in classical conditioning.” Advances in Neural Information Processing Systems, 16: 977-984.

Daw, N.D., Courville, A.C., and Touretzky, D.S. (2003) “Timing and partial observability in the dopamine system.” Advances in Neural Information Processing Systems, 15: 99-106.

Daw, N.D., Courville, A.C., and Touretzky, D.S. (2002) “Dopamine and inference about timing.” Proceedings of the Second International Conference on Development and Learning: 271- 276.

Courville, A. C., Touretzky, D. S. (2002) “Modeling temporal structure in classical conditioning.” Advances in Neural Information Processing Systems, 14: 3-10.

Courville A., Bardakjian B. L. (1999) “Chaosmakers: Rhythmicity Breakers.” Proceedings of the First Joint Meeting of the IEEE Engineering in Medicine and Biology Society and the Biomedical Engineering Society, 1: 406-408.

Bardakjian, B. L., Courville A., Vigmond, E.J. (1997) “Memory of Neuronal Networks: The White Noise Approach.” Proceedings of the 19th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, 3: 1377-1379.

Book Chapters: Bengio, Y., Courville, A. (2013) “Deep Learning of Representations.” Chapter to appear in *Handbook on Neural Information processing*; Bianchini, M., Jain, L., Maggini, M., Eds.; Springer:Berlin Heidelberg.

Daw, N.D., Courville, A.C., Dayan, P. (2008) “Semi-Rational Models of Conditioning: The Case of Trial Order.” Chapter in *The Probabilistic Mind*; Chater, N., Oaksford, M., Eds.; Oxford University Press: Oxford.

Technical Reports: Bergstra, J., Courville A., Bengio Y. (2011) “The Statistical Inefficiency of Sparse Coding for Images (or, One Gabor to Rule them All)” Technical report 1109.6638v2, arXiv.

Erhan, D., Courville, A., Bengio Y. (2010) “Understanding Representations Learned in Deep Architectures”, Département d’Informatique et de Recherche Opérationnelle, Université de Montréal:1355

Desjardins, G., Courville, A., Bengio, Y., Vincent, P., Delalleau, O. (2009) “Tempered Markov Chain Monte Carlo for training of Restricted Boltzmann Machines”, Département d’Informatique et de Recherche Opérationnelle, Université de Montréal: 1345.

Erhan, D., Bengio, Y., Courville, A., Vincent, P. (2009) “Visualizing Higher-Layer Features of a Deep Network”, Département d’Informatique et de Recherche Opérationnelle, Université de Montréal: 1341.

**Abstracts and
Workshop
Articles:**

Goodfellow, I., Courville, A., Bengio, Y. (2011) “Spike-and-Slab Sparse Coding for Unsupervised Feature Discovery”. NIPS Workshop on Challenges in Learning Hierarchical Models: Transfer Learning and Optimization. Melia Sierra Nevada & Melia Sol y Nieve, Sierra Nevada, Spain.

Mesnil, G., Dauphin, Y., Glorot, X., Rifai, S., Bengio, Y., Goodfellow, I., Lavoie, E., Muller, X., Desjardins, G., Warde-Farley, D., Vincent, P., Courville, A., Bergstra, J. (2011) “Unsupervised and Transfer Learning Challenge: a Deep Learning approach”. JMLR W& CP: Proceedings of the Unsupervised and Transfer Learning challenge and workshop. Bellevue, Washington, USA.

Courville, A., Bergstra, J., Bengio, Y. (2010) “The Spike and Slab Restricted Boltzmann Machine.” NIPS Workshop on Deep Learning And Unsupervised Feature Learning. Whistler, BC, Canada.

Desjardins, G., Courville, A., Bengio, Y. (2010) “Adaptive Parallel Tempering for Stochastic Maximum Likelihood Learning of RBMs.” NIPS Workshop on Deep Learning And Unsupervised Feature Learning. Whistler, BC, Canada.

Courville, A. (2008) “The hierarchical indian buffet process.” Workshop on Nonparametric Bayes at ICML/UAI/COLT. Helsinki, Finland.

Courville, A., Bergstra, J., Bengio, Y. (2011) “A Spike and Slab RBM Approach to Modeling Natural Images”. Learning Workshop (“Snowbirds”). Fort Lauderdale, FL, USA.

Courville, A., Erhan, D., Vincent, P., Bengio, Y. (2008) “Sparse Covariance Coding”. Learning Workshop (“Snowbirds”). Snowbird, UT, USA.

Delalleau, O., Courville, A., Bengio, Y. (2008) “Gaussian Mixtures with Missing Data: an Efficient EM Training Algorithm”. Learning Workshop (“Snowbirds”). Snowbird, UT, USA.

R. Vincent, J. Pineau and A. Courville. (2006) “Modeling and Control of Neural Network Dynamics”. Symposium on Computational Neurosciences. Montreal, QC Canada.

Courville, A.C., Daw, N.D., and Touretzky, D.S. (2004) “A Bayesian framework for configural conditioning.” 37th Meeting of the Society for Mathematical Psychology/Journal of Mathematical Psychology. Ann Arbor, MI, USA

Courville, A.C., Daw, N.D., and Touretzky, D.S. (2002) “A semi-Markov model of how the dopamine system handles variability in event timing.” Soc. Neurosci. Abstracts 28: 280.10.

Courville A., Bardakjian B. L. (1998) “Chaos and Rhythmicity in Biological and Artificial Neural Networks.” 14th Annual BMSR Workshop on Advanced Methods of Physiological System Modeling. University of Southern California BMSR, Los Angeles, CA, USA.

Bardakjian B. L., Courville A. (1996) “Memory of Neuronal Networks: The White Noise Approach.” Advanced Workshop on Biological and Artificial Neural Networks: Search for Synergism. University of Southern California BMSR, San Diego, CA, USA.

Talks and Seminars:

“Modèles spike-and-slab d’images naturelles” invited talk, Département d’Informatique et de recherche opérationnelle, Université de Montréal, Montréal QC Canada (Jan 2012).
“Unsupervised Models of Images by Spike-and-Slab RBMs.” The 28th International Conference on Machine Learning, Bellevue, WA, USA (2011).

“A Spike and Slab RBM Approach to Modeling Natural Images.” Learning Workshop (“Snowbirds”), Fort Lauderdale, FL, USA (2011).

“Probabilistic Graphical Models: Representation, Inference and Learning.” invited lecture series, Algorithmes d’Apprentissage (Learning Algorithms), University of Montreal, Montreal PQ Canada (Yearly, 2006–2009).

“Dirichlet Processes : Interpretations, Inference and Extensions” talk, LISA MITACS seminar, University of Montreal, Montreal QC Canada (October 2006).

“Probabilistic Graphical Models.” invited lecture, Music and Machine Learning, University of Montreal, Montreal QC Canada (January 2006).

“Graphical Models: Learning and Cognition” invited lecture, Cognitive Psychology. Department of Psychology, McGill University, Montreal QC Canada (November 2005).

“A Bayesian account of animal learning” invited talk, LISA MITACS seminar series, University of Montreal, Montreal QC Canada (April 2005).

“A latent variable account of configural conditioning.” invited talk, Probabilistic Models of Cognition: The Mathematics of Mind. Institute for Pure and Applied Mathematics, Los Angeles CA USA (January 2005).

“Similarity and discrimination in classical conditioning: A latent variable account.” contributed talk, Advances in Neural Information Processing Systems. Vancouver BC Canada (December 2004).

“A Bayesian framework for configural conditioning.” contributed talk, 37th Meeting of the Society for Mathematical Psychology. University of Michigan, Ann Arbor MI USA (August 2004).

Teaching (Teaching Assistant):

Introduction to Artificial Neural Networks, David S. Touretzky, Carnegie Mellon University (2002).

Bioelectricity, Berj L. Bardakjian, University of Toronto (1997 and 1998).

Program Chair: *International Conference on Representation Learning (ICLR), 2013*

Program Committees: *Neural Information Processing Systems (NIPS) (Area Chair 2008 & 2009)*
International Conference on Machine Learning (ICML)
Conference on Uncertainty in Artificial Intelligence (UAI)
International Joint Conferences on Artificial Intelligence (IJCAI)

National Conference on Artificial Intelligence (AAAI)
International Conference on Artificial Intelligence and Statistics (AISTAT)

Refereeing:

Journal of Machine Learning Research
Transactions on Pattern Analysis and Machine Intelligence
Learning & Behavior
Psychological Review
Journal of Mathematical Psychology
Transactions on Autonomous Mental Development
Neural Information Processing Systems (NIPS)
Conference of the Cognitive Science Society (COGSCI)
IEEE International Conference on Robotics and Automation (ICRA)

Other Service:

Coordinator: Tea Talk Lecture Series, Département d'Informatique et de recherche opérationnelle, Université de Montréal (2009-2011).

Master's Thesis Committee Member, Student: Ethan Tira-Thompson, Robotics Institute, Carnegie Mellon University, Pittsburgh PA USA (2004).

Qualifier Committee Member, Robotics Institute, Carnegie Mellon University, Pittsburgh PA USA (2002).

Class Representative, Robotics Institute Student Organization, Robotics Institute, Carnegie Mellon University, Pittsburgh PA USA (2000-2001).

Member, Biomedical Engineering Students Association Executive, Institute of Biomaterials and Biomedical Engineering, University of Toronto, Toronto ON Canada (1998-1999).

Judge, Stormont, Dundas and Glengary Counties Science Fair, Cornwall ON Canada (1998-1999).

Childcare Volunteer, Child Haven International: Home for destitute and orphaned children, Hyderabad India (1995).

Citizenship:

Canadian